HEPTACHLOR CONTAMINATION OF LIVESTOCK AND POULTRY*

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Introduction

Heptachlor and chlordane are chlorinated hydrocarbon insecticides that are very fat soluble and thus tend to accumulate in the body fat of animals that eat contaminated feeds. The recent contamination of stillage in the midwestern states has led to widespread contamination of dairy cattle as well as other livestock. The finding of violative levels of heptachlor epoxide (the major metabolite of heptachlor) in milk and milk products resulted in the quarantine of many dairies. The contaminated stillage was also fed to beef cattle, swine and poultry. This fact sheet contains information that should be helpful to you if your herd or flock is contaminated. Further information and assistance can be obtained from your local Cooperative Extension agent and campus based specialists, your state Veterinary Diagnostic Laboratory, and your regional FARAD (Food Animal Residue Avoidance Databank) Access Center. This fact sheet focuses on heptachlor which is more persistent in animals than chlordane.

Fate of Heptachlor in Livestock

Absorption: Heptachlor and heptachlor epoxide (HE) are well absorbed from the gastrointestinal tract of animals. Over 80% of the amount eaten is absorbed into the bloodstream. Heptachlor is converted to HE as a result of environmental degradation and metabolism within the body.

Distribution: Heptachlor epoxide is distributed throughout the body and tends to accumulate in body fat.

Metabolism: Heptachlor is metabolized in the body to HE which is then stored in body fat. HE is not further metabolized to any significant extent.

Elimination: The heptachlor and HE not absorbed from contaminated feed are excreted in the feces (manure). Heptachlor and HE that have been absorbed into the animals blood is excreted in milk and feces. In nonlactating cattle and swine, fecal excretion is the predominant route of elimination, and is slow. In lactating animals, milk excretion may account for more than 80% of elimination. Only trace amounts of heptachlor and HE can be detected in the urine. The concentration of HE excreted in milk fat is almost exactly the concentration of HE in body fat. Thus, milk fat HE levels can predict the level in body fat and be used as a guideline for decontamination. Nearly 100% of the HE in milk is in the butterfat because HE is very soluble in fat and very insoluble in water. Heptachlor epoxide is also excreted into eggs produced by contaminated layers.

* See also "HEPTACHLOR CONTAMINATION OF DAIRY CATTLE"

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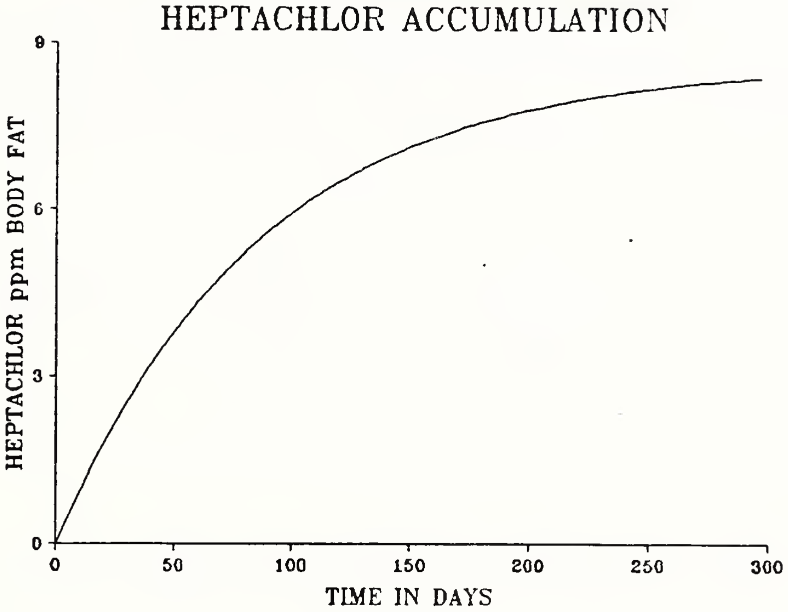
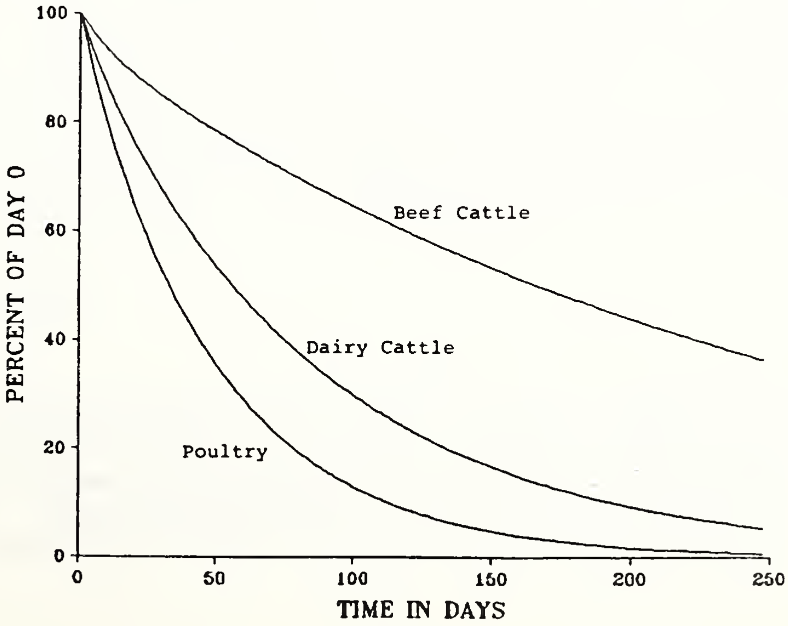
Kinetics (Time Course)
Absorption and Elimination

The following graph shows what happens while an animal is fed heptachlor or HE contaminated feed.



The level in the body fat continues to increase until the amount being excreted equals the amount absorbed. This accumulation may take place over a long time. The shorter the time of exposure, the less the level of accumulation.

The next graph shows what happens to the levels of HE in the body when the contaminated feed is "shut off" and replaced with clean feed.



The concentration of HE in body fat decreases slowly. The rate of elimination for beef cattle normally has a half-life of about 180 days in nonlactating cattle. (Thus every 180 days the concentration drops to 50% of what was there at the start of that 180 day period as shown in Table 1.) This T 1/2 is an average of many cows. Some will have much shorter T 1/2's and others much longer depending on lactation, health status and management factors. The half-life of HE in poultry is about 35 days and this applies to body fat, liver, muscle and eggs. The half-life of elimination of HE from swine is not known at this time, however field incidents involving dieldrin contamination of swine have shown a half-life of about 50 days in finishing swine, and 30 days in growing swine. These half-lives of dieldrin in swine were determined in animals which had not been managed for weight reduction.

Table 1

Concentration in Body Fat	Time (Cattle)	Time (Poultry)	T 1/2
10	0	0	---
5	180 days	35 days	1
2.5	360 "	70 "	2
1.25	540 "	105 "	3

Because of the consistency of this half-life, if we know the time of exposure and the level of HE in the body fat or eggs , it is possible to make good predictions of how long it will take to decrease to the action level of 0.3 ppm for meat products or 0.03 ppm for eggs. All estimates of cleanup times must be verified by testing animals involved. In many instances the animals will cleanup faster than expected.

CONTAMINATION MANAGEMENT

A. General

Identify which groups of your animals have actually been fed contaminated feed. Separate out those animals that were fed none or only very small amounts from those that were fed large amounts. Because chlorinated hydrocarbon insecticides like HE are stored in body fat, mobilization of body fat by weight reduction has been shown to be effective in reducing body burdens of a related insecticide, dieldrin. There is no data available on weight reduction and HE decontamination. It is recommended as a safe and inexpensive experimental procedure that has a good chance of success.

B. Weight Reduction

1. Cattle

The carcass composition of cattle may range from less than 10% fat to greater than 25% fat. The amount of weight reduction that will be effective in speeding the elimination of HE will vary depending on animal condition. One way to determine the amount of weight loss that would result in decreasing body fat by up to 90% is to take the live weight,

subtract 15% for gut contents, and then multiply by the percent fat in the carcass (this last figure would have to be based on the condition of the cattle). For example, for a 600 lb steer in fair condition, subtract 90 lbs (600 x .15) for gut contents, for a weight of 510 lbs. If this animal has about 15% carcass weight as fat, then 510 lbs times .15 is 76.5 lbs. This approach would require testing of representative animals from the contaminated herd in order to prove that the diet worked. Testing can be done by slaughter, or by biopsy of perineal fat samples taken by your veterinarian. When the level of HE in fat has been reduced to the about 1 ppm, the animals can be refattened for slaughter and the dilution effect and excretion will reduce the level to below 0.3 ppm by the time they are finished. This method was used effectively to decontaminate a large herd of cattle that had been exposed to aldrin, a similar pesticide.

Calves born to cows fed contaminated feed will be contaminated at the same level as the dam. **These animals should not be used for veal production.** As the animals grow, they will eliminate the HE in their bodies and it will also be "diluted" as they gain weight. When these calves reach maturity, the weight gain alone with the increase in body fat should result in up to a 40 fold dilution compared to the original residue level. Since the calves will also excrete HE during the two years it takes to grow out, more than 90% of the HE present at birth will be excreted. Thus there is virtually no possibility that calves from contaminated cattle would have violative HE residues when slaughtered after two years growth.

2. Poultry

A weight reduction plan for meat birds would not be economically feasible, however young broilers exposed to moderate levels of heptachlor in feed for a short time may eliminate and dilute the levels to below 0.3 ppm by the time they are ready for market. This should be verified by testing a composite sample of 10 to 15 birds before marketing the whole flock. For layers, a forced molt might be effective in helping to reduce body fat levels and subsequent egg contamination. This diet procedure is recommended only for flocks with low levels of contamination since it is not a proven method of decontamination.

3. Swine

A weight reduction program similar to the one described for beef cattle might work quite well to reduce contamination of adult animals. In addition, excretion and "dilution" of contamination from growth will also help to reduce HE levels in fat. As with cattle, you can continue to use breeding animals since HE will not interfere with reproduction. Piglets will be contaminated when born and will receive HE in sows milk, however the "dilution" factor should allow marketing at 6 months of age provided they are fed "clean" feed. An incident in Iowa in which over 3,000 cattle and 35,000 hogs were contaminated with aldrin (a related pesticide) cost the producer about 1.5 million dollars to clean up his herd, but he was able to salvage about 5 million dollars. The increased holding period for the animals while they underwent decontamination resulted in not only increased feed costs, but also in physical damage to the confinement facilities.

In some situations in which the time it will take to decrease to tolerance is longer than economically feasible, you may decide to get rid of the animals. Consult state and federal officials for proper means of disposal of these animals.

DECONTAMINATION

Antidotes

There have been numerous research trials to test the effectiveness of activated charcoal, mineral oil, phenobarbital, protomone, cholestyramine and thyroprotein in helping to speed up the elimination of HE and other chlorinated hydrocarbon insecticides from dairy cattle. While some of these substances have proven effective in decreasing contamination caused by acute exposure to other similar insecticides, their effects on HE elimination in beef cattle, poultry and swine have not been tested. The strategy of their use is to enhance the fecal elimination of HE. While some of these treatments have been tested in dairy cattle and shown to increase fecal elimination by about 10%, the effect is not dramatic. Activated charcoal and mineral oil will not hurt, but will also be of dubious benefit and add additional cost (not to mention mess). The ability of most activated charcoal preparations to bind chemicals and hasten their elimination from the body varies considerably. **Because the effectiveness of activated charcoal is not proven, it should be considered an experimental procedure and should be carried out only under the supervision of your veterinarian.** The FARAD Midwest Regional Access Center at the National Animal Poison Control Center can provide further information to your veterinarian about the use of a superactive charcoal that is being tested for decontamination effectiveness.

Economics

The decision to "cleanup" a herd or to get rid of it is an individual economic decision that must be made using the best possible data. You may use the following formulae to calculate the time it should take for the levels of HE to decline to the established tolerance or action levels. Keep in mind that dilution of residues during growth, and weight reduction effects will speed up the decontamination process and decrease the time to reach the action level.

For beef cattle:

$$\text{Time} = \frac{\ln\ (0.3/\text{HE ppm in body fat})}{-.0039}$$

For poultry:

(meat)

$$\text{Time} = \frac{\ln\ (0.3/\text{HE ppm in body fat})}{-.0198}$$

(eggs)

$$\text{Time} = \frac{\ln\ (0.03/\text{HE ppm in body fat})}{-.0198}$$

For swine:

(These values are for dieldrin, not HE and should be used only as a general guideline.)

(finishing) $$\text{Time} = \frac{\ln\ (0.3/\text{HE ppm in body fat})}{-.0139}$$

(growing) $$\text{Time} = \frac{\ln\ (0.3/\text{HE ppm in body fat})}{-.0231}$$

For example, if you have beef cattle which have a level of 1.0 ppm HE in fat, the equation is:

$$\text{Time} = \frac{\ln\ (\ 0.3\ /\ 1.0)}{-\ 0.0039} = \frac{\ln\ (0.3)}{-0.0039} = \frac{-1.20397}{-0.0039} = 308.7 \text{ days}$$

(Many handheld calculators can determine the natural logarithm (ln) of a value and thus may be used with this equation.)

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This fact sheet was a cooperative effort of the members of the USDA Extension Service Heptachlor Residue Education Task Force chaired by Arthur L. Craigmill. Members of the Task Force whose materials were used and/or who assisted in editing this fact sheet are:

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